# Summary

This seventh *Puget Sound Update* is based primarily on the findings of the Puget Sound Ambient Monitoring Program (PSAMP). The PSAMP is a long-term effort to investigate environmental trends, improve decision-making and prevent overlaps and duplication in monitoring efforts. The results of the PSAMP are supplemented by the findings of many other efforts to evaluate the condition of Puget Sound's waters, sediments, nearshore habitats and biological resources. Information presented in this report generally reflects conditions through 1998. However, in some cases only older data were available and in other cases results through 1999 were available and included.

Signs of environmental degradation from around Puget Sound suggest that the continuing development in the basin is taking its toll on the Sound. A variety of Puget Sound organisms appear to be in poor condition or their numbers appear to be declining.

Environmental degradation in Puget Sound has been documented for many years. High levels of toxic contaminants in urban bays and waterways and widespread alteration of Puget Sound's estuaries and shorelines can be seen. Puget Sound monitoring provides some signs that conditions may be worsening:

- Levels of fecal contamination have increased in Henderson Inlet and Burley Lagoon—south Puget Sound shellfish growing areas where nearby lands were being developed for residential and commercial uses.
- Incidence of liver lesions in English sole in Elliott Bay (Seattle) has increased, which may reflect increased levels of contamination, especially by PAHs (polynuclear aromatic hydrocarbons), from the Sound's most highly developed urban and industrial lands.

Many measures of the condition of the Puget Sound environment have yet to show a trend. This may, in some cases, reflect stable conditions but in many cases probably results from the difficulty in detecting trends when results vary greatly from year to year and when monitoring records represent only a period of five or six years. A few measures indicate improving conditions. However, on balance, monitoring results suggest that human actions on the developed and developing lands of the Puget Sound basin continue to threaten Puget Sound. The implication is that careful management of Puget Sound's lands and shorelines will be needed to maintain the quality of the Puget Sound environment.

Many species that rely on Puget Sound appear to be declining, including Pacific herring, rockfish, coho salmon, scoters, Western grebes, great blue herons and orca whales. While some species (notably harbor seals) are faring relatively well in recent years, the number and diversity of species in poor or declining condition suggest widespread effects of habitat loss or degradation, harvest pressures cascading through the food web, or natural variations in marine system productivity. More scientific assessment will be needed to understand the causes and implications of declines of marine species in Puget Sound. Key elements of efforts to recover healthy populations of the Sound's organisms will include protection and restoration of habitat and control of harvest.

## Environmental indicators reporting

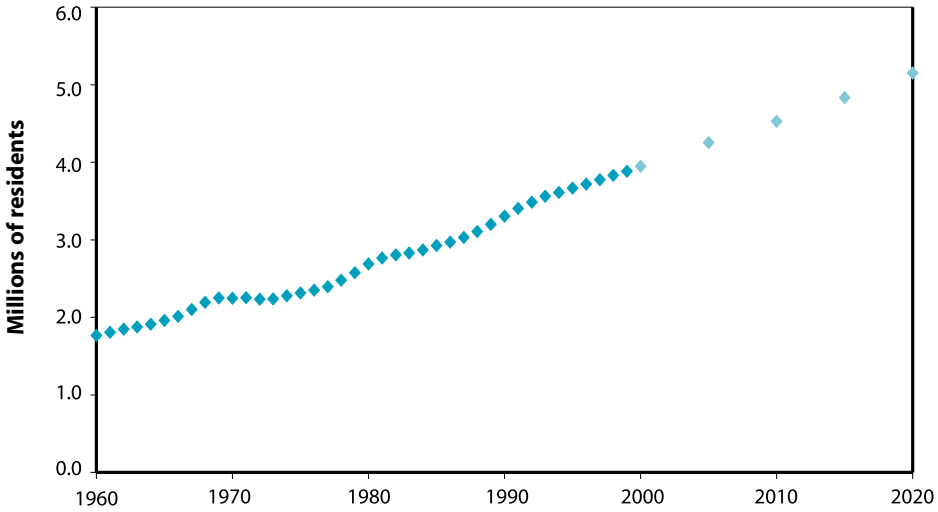
A portion of the information presented in this report is summarized in the Puget Sound Water Quality Action's Team environmental indicators document, *Puget Sound's Health 2000.* The 16-page document provides a brief view of the condition of Puget Sound and its resources. Copies of *Puget Sound's Health 2000* are available from the Action Team and on-line at: http://www.wa.gov/puget_sound.

Other agencies and organizations produce related environmental indicators and status and trends reports. One recent example is "Our Changing Nature," a 1998 report by the Department of Natural Resources, which describes trends in Washington State's forests, grasslands, freshwater systems, marine environments and fish and wildlife.

## Increasing development of the Puget Sound basin

In the four most populous counties of central Puget Sound (King, Kitsap, Pierce and Snohomish), land converted to housing and business developments doubled from nearly 150,000 acres in 1970 to 300,000 acres in 1995 (Puget Sound Regional Council as cited in Washington Department of Transportation, 1998). The Washington Department of Transportation (1998) estimates that an additional 200,000 acres of land in the central portion of the basin will be developed for residential, industrial and commercial uses by 2020.

***Figure 1. Puget Sound's population, 1960-2020***




Source: Washington State Office of Financial Management. 1999.

## Summary of Findings

### Physical Environment

In recent years, the temperature of many Puget Sound basin streams appeared to be so high that it threatened cold-water organisms, including salmon. Intrusions of Pacific Ocean water carrying very little dissolved oxygen into areas of Puget Sound with limited vertical circulation may lead to low dissolved oxygen levels in some of the Sound's inlets and bays, especially in Hood Canal. This natural occurrence can be aggravated by human influences on water circulation and nutrient input so that dissolved oxygen is depleted over a greater area or for a longer portion of the year. As previously reported, Puget Sound's shoreline has been significantly altered from its original condition. Eighty percent of the eastern shore of Puget Sound's main basin from Mukilteo (south of Everett) to Tacoma is no longer in its natural state due to alteration by bulkheads, docks, piers, or some other type of intertidal or backshore alteration.

### Pathogens and Nutrients

Pathogen- and nutrient-related water quality problems are significant concerns in a number of locations around Puget Sound, especially in important shellfish growing areas, near the mouths of major rivers and in bays and inlets where vertical water circulation is limited.

Analyses included in this report indicate that fecal contamination may threaten commercial shellfish harvest in areas of south Puget Sound (Filucy, North and Henderson bays; Burley Lagoon; Nisqually Reach; and Henderson Inlet), some of north Puget Sound's bays and inlets (Drayton Harbor, Saratoga Passage, and south Skagit, Portage and Samish bays) and in Hood Canal at Dosewallips State Park. Conditions at four commercial shellfish growing areas showed two distinct trends over time. Worsening conditions were observed throughout Henderson Inlet and Burley Lagoon, but fecal contamination levels declined in Eld Inlet and Oakland Bay, where concerted efforts by government and citizens identified and addressed contaminant sources.

Monitoring results through the 1990s suggested that some areas of Puget Sound were susceptible to water quality degradation resulting from excess nutrient additions, especially southern Hood Canal, Budd Inlet and Penn Cove.

## Toxic Contaminants

Toxic contaminants are present throughout the Puget Sound environment, though the most serious problems occur in urban areas near contaminant sources. Limited trend information suggests that some types of toxic contamination may be decreasing while other problems may be worsening. Studies in Puget Sound also show adverse effects of toxic contaminants in invertebrates and fish.

Consistent with previous evaluations of sediment and fish contamination in Puget Sound, a 1997 survey of sediment contamination in north Puget Sound found that contamination problems occurred primarily near urban areas. Further evidence of this pattern was seen in higher concentrations of PAH (polycyclic aromatic hydrocarbon) metabolites in fish from urban areas than in those from non-urban areas of Puget Sound.

Information on contaminants in the tissue of mussels and harbor seals and the prevalence of liver lesions in English sole indicates that toxic contamination in Puget Sound has changed over time. Concentrations of PCBs, copper, mercury and DDT and its breakdown products in mussels declined at a few of 11 Puget Sound locations monitored from the mid-1980s to the mid-1990s. This indicates that concentrations of these contaminants in Puget Sound waters have decreased over this time period in at least some areas of the Sound. Levels of PCB contamination in south Puget Sound harbor seals declined significantly from the 1970s to the mid-1980s but remained fairly steady from the mid-1980s to the mid-1990s.

Prevalence of liver lesions in English sole from 1989 to 1998 showed no trends at five of six monitoring locations but showed an increasing trend in fish from Elliott Bay. Scientists previously showed that liver lesions in English sole from Puget Sound were associated with PAH contamination in sediment. The increasing incidence of liver lesions in English sole from Elliott Bay suggests that PAH contamination in the bay may be increasing.

## Human Health

Conditions in Puget Sound can affect the health of the region's human residents, especially through the consumption of fish and shellfish. Fish and shellfish accumulate toxic contaminants from their food. As they filter large amounts of water, bivalve shellfish can also accumulate pathogenic organisms and naturally-occurring toxic chemicals (biotoxins).

State and local health officials assess conditions at shellfish growing areas to manage pathogen-related risks associated with shellfish consumption. Historically, about 136,000 acres of Puget Sound tidelands have been utilized for commercial shellfish production. As of 1999, about 75 percent of this acreage was approved for direct harvest and marketing of shellfish.

In 1997 and 1998, Puget Sound shellfish accumulated relatively high levels of *Vibrio parahaemolyticus,* a naturally occurring bacterium, which led to more than 100 cases of *Vibrio*-related illness associated with Washington seafood. Concentrations of the bacteria and associated illnesses returned to lower (more normal) levels in 1999.

Puget Sound shellfish sometimes accumulate relatively high concentrations of the naturally occurring biotoxin that causes paralytic shellfish poisoning (PSP). Areas where high concentrations of the PSP biotoxin were measured for extended periods of time (more than 90 days) from 1996 through 1998 include Sequim, Discovery and Mystery bays on the Strait of Juan de Fuca; Miller Bay (Kitsap Peninsula) and Quartermaster Harbor (Vashon Island) in Puget Sound's main basin; and Filucy Bay in south Puget Sound.

## Biological Resources

The condition of fish populations in Puget Sound illustrates that many of the Sound's marine populations are declining or in poor condition. In 1999, the National Marine Fisheries Service listed chinook salmon from Puget Sound and summer chum salmon from Hood Canal as threatened under the federal Endangered Species Act. More recently, the National Marine Fisheries Service (NMFS) undertook a review of the status of seven species of Puget Sound marine fish—Pacific herring, Pacific cod, Pacific hake, walleye pollock and quillback, copper and brown rockfish. Based on this review, NMFS may propose listing any or all of these species as threatened or endangered under the Endangered Species Act. Some stocks of Pacific herring, important prey for numerous marine species in Puget Sound, declined dramatically over the past 20 years.

In addition, scientists have documented the presence of more than 50 non-native species in Puget Sound and are monitoring the spread of other non-native species (especially the European green crab and the Chinese mitten crab) along the Pacific coast. Aquatic nuisance species have inflicted large-scale alteration on other ecosystems, including San Francisco Bay and the Great Lakes. By controlling pathways of introduction and responding to introductions that do occur, resource managers hope to avoid similar damage in Puget Sound.

Despite much bad news, a few successes give hope for the future of Puget Sound's biological resources. Under the implementation of the Marine Mammal Protection Act, harbor seal numbers in Puget Sound have increased steadily over the past 20 years. However, the success for seals may be a problem for Puget Sound's fish because harbor seals prey upon some fish populations that are declining. Within Puget Sound, nuisance populations of introduced cordgrasses (*Spartina* species) were controlled, and in some cases eliminated, through the efforts of the Washington Department of Agriculture and a diverse group of partners. In addition, biological resources such as the kelp beds in the Strait of Juan de Fuca and harlequin ducks throughout Puget Sound appeared to be stable through the 1990s.

## Conclusions

Findings presented in this *Puget Sound Update* expand the base of knowledge about conditions around Puget Sound and suggest a number of conclusions about further studies and follow up actions. Some of the more important conclusions supported by the new findings include the following:

- Puget Sound's shoreline has been extensively altered by bulkheads, piers and other structures. This alteration affects the availability and function of soft-bottom nearshore habitats. Land owners and resource managers may need to establish protected areas; use alternative, less harmful approaches to protecting shoreline properties; and undertake habitat restoration projects to protect remaining nearshore habitats and to restore functions that have been lost as shorelines have been altered.
- Worsening water quality conditions at some shellfish growing areas reflect the continuing and growing impact of land development on Puget Sound's waters. Continued shellfish harvest in developed and developing areas of Puget Sound will require ongoing attention to appropriate land-use decisions, land management practices and operation and maintenance of septic systems, stormwater management facilities and other pollution control equipment.

- Monitoring results suggest that some areas of Puget Sound, including southern Hood Canal, Budd Inlet, Penn Cove and East Sound are susceptible to water quality degradation if additional nutrients are introduced to the system. Decisions about the discharge of nutrients from point and nonpoint sources to these areas of Puget Sound should take into consideration the potential ecosystem effects of the nutrient additions.
- Additional study of toxic contamination near urban areas and in the vicinity of wastewater discharges is needed to better understand the distribution of problems, to support cleanup activities, and to characterize the effects that toxic contaminants might have on the Puget Sound ecosystem. Information presented in this report suggests a need for further investigations in Everett Harbor, Sinclair Inlet and Elliott Bay.
- Additional information and analysis are needed to characterize the potential human health risks from consumption of Puget Sound shellfish and fish from contaminated areas. Specificially, additional information is needed on water quality conditions at recreational shellfish beaches that have not yet been characterized and classified.
- Widespread evidence of the declining population of Puget Sound marine organisms suggests the importance of new efforts to protect and recover populations. Recovery plans based on an ecosystem perspective will require additional information about the specific relationships among various Puget Sound species and the influences of various natural and human-caused environmental stresses on marine populations.